CREB

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ENERGY CONSERVATION RESEARCH AND DEVELOPMENT

DRAFT STRATEGY PAPER

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PART A

1. PURPOSE

The Panel of Energy Research and Development has directed that a strategy paper be developed for each task in the Energy Research and Development Program. This paper is concerned with Task 1 -- Energy Conservation Research and Development.

This strategy paper will serve a number of purposes ranging from program planning to project selection and monitoring. It will provide a comprehensive and consistent rationale for Federal Government involvement in Energy Conservation Research and Development. It will also foster effective management practices by providing specific targets within an integrated framework. In addition, the paper will lay the groundwork for future program forecast submissions to the Treasury Board.

To accomplish these objectives, the paper must address the following points:

1) Identify the relevant policies and relate all programs to these policies;

2) Identify the Federal Role and explain the links to the role of the provinces, foreign governments and international organizations;

3) Specify federal organizational structure for Energy Conservation Research and Development;

4) Describe program rationale and operating plans.

2. INTRODUCTION

The sudden curtailment of petroleum supplies in 1973 and the subsequent dramatic increase in prices brought to the forefront the crucial role of energy in national well-being. Science and technology assumed a more fundamental importance in energy supply and energy usage patterns.

In 1974, the federal government set up an Interdepartmental Task Force to assess the contribution that science and technology could make to alleviate Canada's energy problems and to recommend research and development (R&D) programs aimed at producing the necessary technology. The Task Force developed a plan for R&D in five areas and set up an

Interdepartmental Panel on Energy R&D supported by an Office of Energy R&D (OERD) to manage the program. During the same period, the government created an Office of Energy Conservation (OEC) with the responsibility to develop and manage the energy conservation program and to coordinate conservation R&D.

The conservation R&D program was delineated along departmental lines and was based on existing programs. The delineation meant that energy conservation was de facto defined as (1) an increase in the efficiency of utilization (2) reduction of material waste and (3) a change in the way things are done.

3. POLICY FRAMEWORK

These and other aspects of energy policy development were formalized in a broad energy policy framework, entitled "An Energy Strategy for Canada." The objective of the strategy is energy self-reliance; energy conservation and increased research and development are two of the major policy elements. These policy elements are aimed at reducing the average rate of growth of energy use in Canada over the next ten years to less than 3.5% per year. This is a short-term strategy which applies to the next fifteen years. Consequently, this strategy governs R&D which will have an impact over the short-term, essentially R&D at the demonstration stage.

Energy policy has not yet been formalized for the medium and long terms. Energy R&D, however, will continue to be an important element in energy policy. In the medium and longer terms, energy R&D will provide some direction for future policy development.

Energy conservation policy is directed toward filling the projected gap between demand and supply in the short term by reducing the average annual energy growth rate to 3.5%. The demonstration and commercialization of energy conservation technologies will play an important role. In the longer-term, energy conservation policy must provide the basis for efficient patterns of energy production and use. This long term policy initiative must respond to factors beyond energy considerations, such as increasing waste heat discharge into the environment, increasing carbon dioxide levels in the atmosphere, and increasing generation of solid waste. In essence, this policy defines the long term R&D strategy.

Energy conservation R&D policy interfaces with a broad spectrum of government policies at varying levels of importance. Some of the most important of these other policies are related to science, the environment, industrial development, food, regional development and transportation. In general, energy conservation will be beneficial to these other areas.

Science policy directly influences the nature and conduct of energy conservation R&D. In the context of science policy, the energy R&D program is a government priority program, and as such will consist mostly of applied R&D. Basic science is conducted through the granting councils. The energy R&D program is not intended to fund the demonstration and commercialization stages of the R&D process. Demonstrations are best addressed through federal/provincial agreements and DREE arrangements, and other programs, although small projects will come under the Panel.

The "Make or Buy" policy governs through DSS the conduct of all government contract R&D.

4. FEDERAL ORGANIZATION FOR ENERGY CONSERVATION R&D

The overall coordination of the energy R&D program is provided by the Panel on Energy R&D, supported by OERD. The program is divided into six tasks as follows:

1) Conservation
2) Fossil fuels
3) Nuclear energy
4) Renewable resources
5) Energy transmission and transportation
6) Overall coordination

Each task is coordinated by a designated government agency. Tasks 1 -- Conservation -- is coordinated by the Technology Development Coordinator of CREB. Task 1 is highly diversified, comprising a variety of disciplines loosely organized under the term conservation. It is broken down into ten programs, coordinated by various government agencies, as follows:

	PROGRAM	LEAD AGENCY
1.1	Increase energy efficiency in commercial buildings and residences	NRC
1.2	Increase energy efficiency in the transportation system	TC

	PROGRAM	LEAD AGENCY
1.3	Improve energy efficiency in the food supply system	CDA
1.4	Recovery of energy from thermal power plants	EMR
1.5	Municipal and industrial waste energy	DFE
1.6	Increase energy efficiency in the burning of oil and gas	EMR
1.7	Increase energy efficiency in industrial processes	IT&C
1.8	Energy conversion, heat transfer and storage	NRC
1.9	Energy and urban form	MSUA
1.10	Consumer products and lifestyles	CCA

The Panel represents a new concept for interdepartmental R&D and as such has a number of teething problems. The major problems are the scope of work to be done under the Panel in relation to departmental priorities, and the ease of transferring funds across programs and tasks.

There are two approaches to the conduct of conservation R&D. The major government laboratories which handle most of the technical R&D, i.e. NRC and CANMET, operate by conducting R&D in-house and contracting out work related to these in-house programs. Most of the other research across the task is contracted out, but is managed by the coordinating departments, which do not have a substantial R&D in-house program.

5. OPERATION AND MANAGEMENT OF ENERGY CONSERVATION RESEARCH AND DEVELOPMENT

The delineation of what constitutes R&D from the Panel's viewpoint has undergone several modifications. The Treasury Board had defined the R&D function of the Panel to exclude activities such as resource assessment, environmental assessment, socio-economic data collection health and safety programs and waste disposal (as distinct from waste recovery). Treasury Board felt that these activities should be funded under the departmental mandate as distinct from the energy program.

This definition was subsequently revised in the case of conservation R&D to include socio-economic and policy-related studies. This, however, is not in accordance with R&D as defined by MOSST and Statistics Canada. Many of the inclusions are more properly defined as related scientific activities. Government R&D itself is not an isolated program, but is part of the entire innovation process. The innovation process can be seen as comprising several steps incorporating several feedback loops: applied research, development, demonstration and diffusion of technology. Market research should form part of the development step.

Diffusion of technology is accompanied by a number of other factors such standardization and testing, servicing and maintenance, government regulation, and market development. The Panel is directly responsible for applied research and development. Demonstration and diffusion, however, must be dealt with differently since the major actors are not the same.

Panel energy conservation R&D should include the following activities:

1) "technology assessments" to determine what the R&D program should include, including overall assessments for determining priorities,

2) data collection if it is done for the purposes of assessments or as part of a research project,

3) assessments of the demonstration and commercialization needs of a new technology, including market studies,

4) new methods of standardization and testing

Ideally, studies to determine engineering feasibility and energy policy needs, socio-economic assessments for policy purposes, health and safety programs, environmental assessments and resource assessments should not be included in panel R&D. These matters are already included in the mandates of various government departments and should be part of their ongoing work. In practice, this is not the case, and a number of departments view the Panel as the source of funds for these activities.

The federal government is engaged in energy conservation R&D not merely for the development of technology, but for a number

of other related reasons. The government does R&D in certain areas at a minimum level in order to maintain a basic expertise to monitor foreign programs which may result in technologies of interest to Canada. Another reason for government R&D is to form the basis for regulations through the development of standards and testing procedures. A third reason is to enhance the capability of Canadian industry to perform R&D.

There is no provision under the Panel for cooperation with the provinces for energy conservation R&D at this time. Cooperative R&D projects can however be undertaken under federal/provincial agreements in energy conservation. These will generally be in areas of high federal/provincial priority.

A prime objective of technological R&D is the development of a marketable product. Therefore, it is important that industry be closely involved at the beginning of the program. In the ideal case the R&D program should originate with industry.

The main route for international cooperation is through the International Energy Agency. Since most countries prefer to operate through this route, attempts to seek bilateral cooperation in energy conservation R&D projects are not likely to succeed. No formal provisions exist for international cooperation in the Panel R&D program, although the Panel is funding a number of cooperative programs.

Programs have generally been selected from a Departmental viewpoint, which may not necessarily coincide with the Panel's perspective of the energy conservation R&D program. This has resulted in a number of activities under the Panel which serve purposes of departmental policy formulation.

Programs should be selected primarily from the energy conservation viewpoint, but should be based on other equally important criteria, as follows:

1. need for federal government involvement,
2) cost-benefit analysis,
3) cooperation with the provinces and the private sector,
4) implementability of expected results, including constraints to implementation,

5) opportunities for development of Canadian industry,

6) existence of adequate Canadian expertise

In addition to these criteria, projects within programs require more specific assessments as follows:

1) extent to which they meet program goals,

2) where work should be done and who should do it,

3) project priority in relation to the program,

4) project costs

In general, the selection of R&D projects is based on the knowledge and expertise of the program managers working within the guidelines of the overall R&D strategy approved by the Panel.

PART B

PROGRAM 1.1 - BUILDINGS

A. Rationale

Energy used in commercial buildings and residences for heating, cooling, lighting and water heating accounts for about 30% of total Canadian energy consumption.

It is estimated that by 1990, application of existing technology, and modified existing technology such as retrofitting existing buildings, improved designs for new buildings, efficient operation of HVAC equipment and utilization of energy efficient equipment could reduce energy usage by 35% below the level that would have occurred if pre-1973 trends had continued.

Longer term estimates are that these savings could be increased to about 45% or more with the application of technologies such as district heating, energy efficient community designs and total energy systems, in addition to building specific devices and designs.

These savings are realizable through institutional changes, existing technologies and new technologies resulting from R&D.

Very little buildings research is being done by either the private sector or the provinces, although building codes are a provincial government responsibility. NRC has historically played the leading role in this area, disseminating their findings through prescriptive building codes.

B. Program Organization And Management

The program is managed by the Division of Building Research of NRC which is also responsible for the solar energy use in buildings programs, heat pumps in buildings and some aspects of district heating. DPW, as owner and operator of federal government buildings, has a direct interest in the program. CMHC also has an interest in the program, especially through the CHIP program.

NRC disseminates its research results in the building area through prescriptive building codes. These codes are

published under the auspices of the Associate Committee on the National Building Code.

NRC generally performs R&D by developing a cadre of in-house expertise performing much of the research and contracting out where outside expertise exists.

NRC has extensive links with provincial bodies. HUDAC and material and equipment manufacturers.

C. Program Objectives

The objectives of Program 1.1 are as follows:

1) to develop building codes incorporating energy conservation practices;

2) to develop energy budget standards for new construction;

3) to develop operating standards for commercial buildings;

4) to demonstrate energy conserving technologies;

5) to monitor performance of codes and budgets;

6) to develop novel building designs;

7) to provide technical back-up to CHIP

DRB also tests and develops standards for new insulation and other building materials.

D. Program Definition

There are three basic components for research in energy conservation in buildings: demographics (e.g. building stock), economics (e.g. fuel price, income elasticities), and technology. The first two components are policy research which is the function of CREB. Technological research is the function of the Panel.

Program 1.1 addresses energy conservation R&D in two broad categories of buildings: residential, and commercial and institutional buildings. The program should address the following elements which are common to both types of buildings:

1) the building envelope

2) mechanical and electrical systems

3) internal environment

4) building orientation and other site-related aspects

5) system performance

Within these elements, the residential buildings program should include the following project areas:

1) insulation

   - new materials
   - retrofit

2) lighting

3) passive solar and site-related considerations

4) new building components

5) new design concepts

6) air infiltration

The commercial and institutional buildings program should include the following project areas:

1) HVAC systems operation

2) energy budget standards

3) new building components

4) new design concepts

5) environmental conditions

   - lighting
   - humidity
   - temperature

6) electronic control devices

There are a number of other building-related subject areas which are not covered under this program. These exclusions are as follows:

1) heat pump systems (Program 1.8)

2) furnaces (Program 1.6)

3) appliances such as business machines, and water heaters (Program 1.10)

4) solar heating and cooling systems (Task 4)

5) heat recuperation systems (Program 1.4)

6) heat storage (Program 1.8)

7) district heating (Program 1.4)

8) community systems (Program 1.9)

Although the above areas are excluded from Program 1.1, it is important that the program convenor remains fully aware of developments in these other areas.

Demonstration projects in Program 1.1 should do the following:

1) confirm the economic feasibility of building in conformance with the requirements of the energy standards;

2) check the validity of the analytical procedures and data that have been developed;

3) familiarize designers, contractors and operators with the energy conservation standards;

4) bring to light any problems with interpretation, implementation, or enforcement that may have been overlooked in the preparation of the standards.

Demonstration projects must be done in cooperation with HUDAC, or members of HUDAC. These projects will generally not be expensive. For these reasons demonstrations should remain within the program.

E. Program Implementation

The program can be broken down into the following sub-programs:

SUB-PROGRAM		OBJECTIVE
1.1.1.	Insulation	To develop methods for re-insulating existing buildings, and to develop standards for new insulation material.
1.1.2	Internal environmental conditions	To determine satisfactory levels of temperature, humidity, lighting and air quality for building occupancy requirements.
1.1.3	Site-related factors	To determine the optimal building configuration in relation to factors such as wind, sun and vegetation.
1.1.4	Energy budget	To develop energy budget methodology and standards for preconstruction and operation of buildings.
1.1.5	HVAC system operations	To develop efficient operating procedures for HVAC systems.
1.1.6	Electronic control devices	To develop improved devices to control building internal environmental conditions.
1.1.7	New building components	To develop advanced thermally resistive components such as windows, doors and heat storage bricks.
1.1.8	New design concepts	To examine speculative concepts such as underground buildings.

The results of the sub-programs on insulation, internal environmental conditions, site-related factors, energy budgets, and HVAC system operations will be implemented through the building code, or through demonstrations, with HUDAC. These programs will have their impact in the short and medium terms. The work will be done in NRC and through the private sector.

The remaining three sub-programs will have an impact in the long term. Generally, this work will be done in NRC and through unsolicited proposals.

SUB-PROGRAM	TIME PERIOD		
	1979-85	1985-2000	beyond 2000
Insulation			
. methodology	_____		
. standards	_____		
Internal environmental conditions			
. lighting	_____		
. temperature	_____		
. humidity	_____		
. air quality	_____		
HVAC systems	_____		
Site-related factors	_____		
Energy budgets	_____		
Electronic control devices	_____	_____	
New building components	_____	_____	
New design concepts	_____	_____	

F. International Cooperation

The IEA is the most important forum for international cooperation in building energy conservation R&D. Other agencies such as NATO and the UN have an interest in building energy conservation R&D, but it is unlikely that any useful R&D cooperation will result from these links. Rather these agencies can be used to maintain an awareness of foreign programs.

In the IEA, there is an implementing agreement for building energy conservation R&D which has so far completed one annex on ekistics and work is continuing on energy budgets for commercial buildings. Canada has joined the annex on energy budgets. Other annexes have been proposed. Canadian involvement in any new annex must be closely related to the domestic program.

PROGRAM 1.2 - TRANSPORTATION

A. Rationale

Passenger and freight transportation currently consume about 25% of Canadian secondary energy as fuel for motive power. Another 15% of secondary energy is used indirectly by the transportation sector through vehicle manufacture, infrastructure construction and other support processes. Transportation is almost entirely dependent on petroleum as a fuel with the result that about 42% of all petroleum used in Canada is consumed by this sector.

The transportation sector offers considerable scope for energy conservation. It has been estimated that transportation energy demand in 1990 could be reduced to about 65% of the demand level that would occur if current trends prevail. This reduction could be achieved through currently available technical and operational measures if ways can be found to implement them.

The federal government has an obvious interest in R&D for energy conservation in the transportation sector for a number of reasons. First, much of the petroleum used by the sector is imported and imports are a federal responsibility. Second, air and rail services are under federal jurisdiction. Third, manufacturing and importation of road vehicles are federal responsibilities.

B. Program Organization and Management

Program 1.2 is managed by the Strategic Studies Branch (TDSS) of the Strategic Planning Group in Transport Canada. TDSS also coordinates Task 5 of the Energy R&D Program. Transport Canada also has a Research and Development Branch which has expertise in the area of technology development.

To date, most of the research undertaken by TDSS has been done by the private sector through contracts with consulting firms resulting from unsolicited proposals. Selected aspects of the program are addressed by NRC and CANMET.

The results of the R&D work performed under Program 1.2 must be made known to those federal and provincial bodies that have a mandate to implement energy conservation measures. The relevant federal government groups include the Conservation and Renewable Energy Branch of EMR and the Air,

Surface and Marine Administrations of Transport Canada. These departments can implement useful R&D findings in a number of ways including information dissemination to the public and standards for industry.

C. Program Objectives

The objectives of Program 1.2 are as follows:

1) to analyze the energy efficiency of transportation systems in Canada,
2) to identify areas offering significant opportunities for conservation of petroleum through its more efficient use as a result of improved technical characteristics and operational measures, and through the availability of alternative fuels,
3) to contribute to the development of more energy efficient transportation systems in those areas where the potential is significant and where the federal government has a reasonable degree of influence over the manufacture of vehicles, the construction of infrastructure and the operation of transportation services.
4) to investigate the feasibility of using alternate technologies such as teleconferencing as a partial substitute for transportation over the longer term.

D. Program Definition

The component parts of the transportation system are addressed by this program to varying degrees. These components comprise automobiles and light duty vehicles, trucks, buses, trains, aircraft and marine services. The transportation system is further divided into its urban and interurban components, and into passenger and freight services.

Within this context, the program should address the following areas:

1. assessment of the technical efficiency of fuel utilization of each transportation mode,
2. assessment of the technical efficiency of indirect energy utilization of transportation systems,
3. to assess the extent and implications of fuel degradation under Canadian conditions,
4. to work with industry in developing methods of alleviating fuel degradation,

5) to assess the performance of alternate fuels under Canadian conditions, eg. diesel, methanol, hydrogen, etc.,
6) to perform technical assessments of electric vehicles and hybrid vehicles with the assistance of industry,
7) to work with industry in assessing modifications to automobile sub-systems, such as cooling systems and lubricants to improve fuel economy,
8) to assess the feasibility of improving the energy efficiency of locomotives through rail electrification or other means,
9) to develop operational measures for improved overall energy efficiency in transportation services if the technical, institutional and social barriers to implementation are not severe, eg. urban transportation measures such as flexible hours, restricted zones, etc.,
10) to assess the feasibility of energy conservation in transportation through changes in urban form, industrial location, and increased use of telecommunications and teleconferencing,
11) to maintain an awareness of R&D efforts on vehicles in foreign countries.

The following areas should be excluded from Program 1.2:

1) design of engines or new power plants,
2) design of vehicles,
3) battery research (Program 1.8),
4) flywheel development (Program 1.8),
5) retrofit devices for automobile engines,
6) vehicle maintenance research,
7) design of infrastructure, eg., highways airports,
8) ongoing collection of fuel utilization data for existing fleets,
9) availability of alternate fuels,
10) assessments of the feasibility and implications of modal shifts (CREB)

E. Program Implementation

The program can be broken down into the following sub-programs:

SUB-PROGRAM	OBJECTIVE
1.2.1 Automobiles, light duty vehicles and trucks	To determine the effects of Canadian conditions on fuel economy; to maintain an awareness of technical improvements in vehicles; and to contribute to the development of technical and operational improvements where warranted (as a result of an assessment of barriers to implementation and energy conservation potential).
1.2.2 Rail	To contribute to the development of technical improvements to locomotive fuel utilization and operational improvements in the rail passenger and freight system.
1.2.3 Air, bus and marine	To determine the effects of Canadian conditions on fuel economy; to assist the Canadian urban bus industry in developing technical improvements in fuel efficiency; and to contribute to operational improvements in the air, bus and marine passenger and freight systems where warranted.
1.2.4 Energy substitution	To assess the feasibility of supplying motive power through non-petroleum energy sources, such as methanol, hydrogen, and electricity, particularly in automobiles, buses, trucks and rail locomotives.

SUB-PROGRAM	OBJECTIVE
1.2.5 Travel substitution	To assess the feasibility and potential for a reduced need to travel through changes in urban form and the introduction of technologies such as teleconferencing.

The scope of Program 1.2 is extensive because transportation systems are complex. An effective R&D effort cannot be made in all areas. The first phase of the program should select areas of R&D with the greatest potential energy conservation impact in Canada. This impact can be estimated after performing assessments of potential energy savings, technology assessments and assessments of economic, institutional and social barriers to implementation.

In some areas where extensive R&D by the federal government is not justified, a level of awareness of industrial or foreign R&D should be maintained. For example, the federal government should be aware of R&D on new automobile engines which is being done by the automobile manufacturers.

The results of the program can be implemented only through the cooperation of the various Administrations of Transport Canada, CREB, provincial governments and the vehicle manufacturers. As a result, it is preferable to involve these interested parties more directly in the R&D effort.

SUB-PROGRAM	TIME PERIOD		
	1979 -1985	1985 -2000	Beyond 2000
1.2.1 Automobiles, light duty vehicles and trucks	_____		
1.2.2 Rail	_____		
1.2.3 Air, bus and marine	_____		
1.2.4 Energy substitution	_____		
1.2.5 Travel substitution	_____	_____	_____

F. International Cooperation

A substantial amount of work on energy conservation R&D in transportation systems is currently underway outside Canada. The automotive industry in the United States, Japan and Europe is especially active in the area.

Formal international cooperation is limited to meetings and proceedings of technical societies and institutions. Some information interchange takes place through the OECD.

PROGRAM 1.3 - FOOD SYSTEM

A. Rationale

Energy consumption in the food system accounts for about 12 to 15% of total energy use in Canada. This energy is used in farm production, processing, transportation, distribution and home preparation and storage. Eighteen percent of this total is used in farm production and 32% in food processing, with the remainder in transportation, distribution and home preparation and storage.

Canadian agriculture is a very efficient producer of food and feed, and is highly mechanized, labour efficient, capital intensive, and extremely energy dependent. In farm production, the major energy source is petroleum fuels (mainly diesel and gasoline with lesser quantities of natural gas, propane and heating oils) for mobile operations, grain drying, space heating and irrigation. Agriculture also uses large amounts of indirect energy through the manufacture of machinery, fertilizers and chemicals.

No quantitative estimates of possible energy savings through new technologies in agriculture are available at this time. However, any energy savings would be significant since it would enhance the viability of Canadian food production. Changes in agricultural practices must be carefully weighed against a number of other factors, not the least of which is the short growing and harvesting time window.

The energy situation in the food processing industry is not unlike that of other secondary industries. Substantial savings are realizable through process modification, operations modification, waste utilization and market modification.

Agriculture has always been a federal government priority and agricultural research in Canada is generally done by Agriculture Canada which maintains a network of regional labratories.

B. Program Organization and Management

Program 1.3 is managed by the Engineering and Statistical Research Institute of Agriculture Canada. The program is part of the newly - constituted Agricutural Engineering Research and Development (AERD) Program of Agriculture Canada, which also includes renewable energy resources.

Agriculture Canada also supports basic research in areas such as development of new types of wheat and nitrogen - fixing grain.

Agriculture Canada generally disseminates its research results through its regional offices through demonstration projects.

The AERD Program is wholly contracted out to the private sector and universities.

Program 1.3 is a very small program and is not yet well developed.

C. Program Objectives

The objectives of Program 1.3 should be as follows:

1) to improve the energy efficiency of mechanized equipment,
2) to increase the energy efficiency of mobile operations (eg. by reduced tillage and combined operations),
3) to increase the energy efficiency of the greenhouse industry,
4) to increase the energy efficiency of non - mobile operations (eg. lifestock shelters and grain drying),
5) to investigate "novel" concepts, such as crop rotation and sewage sludge as fertilizer,
6) to increase the energy efficiency of food processing operations,
7) to reduce needs for processing and develop new processes.

D. Program Definition

Program 1.3 addresses energy conservation R&D in two broad categories: the farm, and the food processing industry. On the farm the following project areas should be included: -

1) reduced or zero tillage,
2) combined operations,
3) grain drying,
4) livestock buildings, insulation and heating,
5) energy conserving greenhouses,
6) novel concepts, eg. crop rotation, sewage sludge as fertilizer, mechanical cultivation.

In the food processing industry, the following project areas should be included:

1) Energy cascading
2) New processes

There are a number of other building-related subject areas which are not covered under this program. These exclusions are as follows:

1) heat pump systems (program 1.8),
2) applications of wind and solar energy (Task 4),
3) biogass and methanol production and use (Task 4),
4) development of new farm machinery,
5) novel concepts such as nitrogen - fixing grain.

It is expected that this program will concentrate on development of new processes, systems and methodologies, rather than hardware although some new hardware development can be foreseen.

As in Program 1.1, demonstration projects in this area will not generally be expensive and should be retained under the Program. Demonstration projects in this area will be aimed at convincing the farming community of the technical and economic viability of new technology. They will generally be done in cooperation with individual farmers or farmer's associations.

E. Program Implementation

The program can be broken down into the following sub-programs:

	SUB-PROGRAM	OBJECTIVE
1.3.1	Mechanized equipment	To improve the energy efficiency of mechanized equipment.
1.3.2	Mobile operations	To develop "new" energy efficient mobile operations such as reduced tillage and combined operations.

	SUB-PROGRAM	OBJECTIVE
1.3.3	Non-mobile operations	To develop new energy efficient systems for non-mobile operations (eg. heat pumps for grain drying and building heating)
1.3.4	Greenhouses	To develop energy efficient designs for greenhouses.
1.3.5	Novel concepts	To research and develop novel concepts such as crop rotation and sewage sludge as fertilizer.
1.3.6	Food processing	To increase the energy efficiency of current processes and to develop new processes.

SUB-PROGRAM	TIME PERIOD		
	1979 -1985	1985 -2000	Beyond 2000
Mechanized equipment	_____		
Mobile operations	_____	_____	
Non-mobile operations	_____		
Greenhouses	_____		
Novel concepts	_____	_____	
Food processing			
-current processes	_____		
-new processes	_____	_____	

At present, only the sub-program on greenhouses is being carried out under Program 1.3. Some work on mechanized equipment, mobile operations, non-mobile operations and food processing will be done through the new AERD program using Agriculture Canada funds. Since these activities reflect Agriculture Canada's priorities, it should fund some of the work. However, work that is directly related to energy

conservation R&D should be funded under the Panel.

The Program should respond to novel concepts for long term impact, mainly through unsolicited proposals.

F. International Cooperation

No real scope for international cooperation exists. The IEA is considering an implementing agreement on energy conservation in agriculture. However, it is unlikely that this agreement would be of much interest to Canada because of the nature of our agricultural practices and climatic conditions. Bilateral cooperation with the United States should be pursued.

PROGRAM 1.4 - ENERGY SYSTEMS

A. Rationale

Until recently, energy has generally been considered for single process usage in a system of processes, at least in North America. This approach has of course resulted in large quantities of waste heat.

Waste heat from thermal generation of electricity amounts to about 0.4×10^{15} BTU per year; this is expected to rise to about 1.8×10^{15} BTU by 1990, or about 17% of total energy requirements in that year. Although there is limited potential for use of waste heat from existing plants due to a number of factors, the potential from new cogeneration plants is much more promising, especially with storage capability.

The potential for utilization of waste heat in the industrial sector, which uses large amounts of process steam and electricity, is also believed to be substantial. Industrial energy systems could be designed to use energy more efficiently by reducing waste heat by cogeneration for heat only systems. In both the utilities and industry, the waste heat could be used to feed district heating schemes or other plants in an industrial complex.

There is also a potential for total energy systems in small communities and building complexes such as shopping centres, housing projects and hospitals.

Generally, the technologies in this area are mature and are already used in Europe and in isolated North American locales. Although there are some technical problems, the major considerations are economic, institutional and engineering in a Canadian context.

B. Program Organization And Management

Overall coordination of the program is provided by CREB. The technical aspects of district heating including storage is handled by the Division of Building Research of NRC. The technical aspects of cogeneration and of cascading in industry is handled by CANMET. The economic and institutional problems are addressed by CREB.

This program must have extensive links with Programs 1.5, 1.6, 1.17, Program 2.4 of Task 2, and Program 4.3 of Task 4.

The federal government should adopt an integrative role, filling in gaps in the work being done by the provinces and industries and participating in cooperative programs.

C. Program Objectives

The objective of Progream 1.4 are as follows:

1) to assess the potential for cogeneration by power utilities across Canada using a variety of front-end equipment and to design demonstration plants with community space heating and/or industrial process heat,

2) to assess the potential for on-site power generation by industry across Canada and to investigate means to achieve this potential,

3) to assess the potential for industrial energy cascaded systems within individual plants and across plants in industrial complexes, and to design systems to achieve this potential,

4) to develop district heating distribution systems including items such as heat flow meters,

5) to develop technologies for sensible heat storage in geological formation for district heating systems,

6) to develop total energy systems using a variety of front end equipment for building complexes and small communities.

D. Program Definition

The program should include the following:

1) technology assessment of cogeneration schemes for power utilities,

2) technology assessment of on-site power generation by industry,

3) technology assessment of industrial energy cascaded systems,

4) district heating distribution systems including items such as heat flow meters,

5) geological storage of sensible heat for district heating,

6) diesel-based total energy systems,

7) design of demonstration plants for cogeneration for power utilities, on-site power generation, and industrial energy cascaded systems.

The following areas should be excluded:

1) low-grade waste heat utilization for agriculture and aquaculture (Program 1.3),

2) fluidized bed development (Task 2),

3) advanced power cycles,

4) MHD and thermionic topping cycles.

The role of this program is to develop energy systems with basic units of hardware developed in other programs (i.e. 1.5., 1.6., and Tasks 2 and 4).

E. Program Implementation

The program can be broken down into the following sub-programs:

	SUB-PROGRAM	OBJECTIVES
1.4.1	Cogeneration - Power Utilities	To assess the potential for cogeneration by power utilities and to design demonstration plants with community space heating and/or industrial process heat.
1.4.2	Industrial on-site power generation	To assess the potential for on-site power generation by industry and to investigate means to achieve this potential.
1.4.3	Energy Cascaded systems	To assess the potential for industrial energy cascaded systems within individual

		plants and across plants in industrial complexes, and to design systems to achieve this potential.
1.4.4	District heating systems	To design district heating distribution and storage systems and to develop control equipment.
1.4.5	Total energy systems	To develop total energy systems for building complexes and small communities.

Cogeneration in power utilities should be done in conjunction with CEA and municipalities. Industrial on-site power generation and energy cascaded systems should be done in cooperation with industry through industry associations such as FERA and PPRIC and the Industrial Energy Conservation Task Forces. District heating systems should be done to support a number of federal initiatives.

SUB-PROGRAM	TIME PERIOD		
	1979 -1985	1985 -2000	Beyond 2000
Cogeneration-Power Utilities	———		
Industrial on-site power generation	———		
Energy cascaded systems			
. single plant	———		
. industrial complexes	———	———	
District heating systems	———		
Total energy systems	———		

F. International Cooperation

The IEA has an implementing agreement on energy cascading which Canada has joined. At present, there is only one annex which is a market study on cascading technologies. No decision has yet been made on further annexes, although a number of possibilities have been discussed. The domestic program

should be developed before further annexes are signed.

The ECE had a seminar on combined heat and power. Although participation in an ECE program is not likely to result in any useful R&D cooperation, it is a useful forum for maintaining an awareness of international developments in the field.

PROGRAM 1.5 - MUNICIPAL AND INDUSTRIAL WASTE RECOVERY

A. Rationale

Waste recovery confers several important benefits. These benefits are gained through the reduction of the volume of waste discarded to landfills and dumps; recycling of reusable wastes; and utilization of combustible wastes as energy sources.

The amount of energy available from municipal wastes in Canada, considering only those communities with populations of 170,000 or more, represents about nine million barrels of oil, or between 3 and 7% of the total energy used for home heating per year. The energy potentially available from industrial wastes is in the order of 80 million barrels of oil per year which is equivalent to 15 to 30% of the total energy used for home heating.

In addition, a number of probable second order benefits exist. For example, use of reclaimed materials would save part of the energy required to process virgin resources. Waste reduction and disposal is the responsibility of the provinces. Generally, however, DFE has provided leadership in the area of waste reduction and municipalities have looked to DFE for the necessary R&D and demonstration. Since the technologies will be similar for all regions in Canada, coordination should exist at the federal level.

There is considerable foreign activity in this area and a number of technologies in various states of development are available. The major problems are related to the technical and economic viability of these systems and to institutional and logistical questions.

B. Program Organization And Management

The program is managed by the Solid Waste Management Branch (SWMB) of DFE whose prime orientation is solid waste reduction. At present, the whole program is directed at material recovery systems and logistics within the federal government. This work has generally been performed by the

SWMB through cooperation with various federal departments. There are also some ongoing projects in cooperation with the provincial governments. A cost-shared program with industry for technology development and demonstration (DRECT) has recently been developed.

C. Program Objectives

The objectives of Program 1.5 should be as follows:

1) to develop processes for the production of fuels from combustible municipal wastes,

2) to modify processes for direct incineration of combustible municipal wastes for the production of heat for space heating, municipal operations and electricity generation,

3) to develop systems and processes for the utilization of sewage for the production of methane, heat and fertilizer,

4) to develop systems for material recovery and reuse from municipal and industrial waste.

D. Program Definition

There are four principal areas for research under this program: combustion, pyrolysis, bioconversion and material recovery.

Under combustion, the following should be considered:

1) cogeneration,

2) heat production for municipal operations,

3) district heating,

Implicit in the above are the following factors: collection, sorting, burning, power production, heat distribution and residue disposal.

Under pyrolysis, include high-temperature and low-temperature pyrolysis to produce oil, gas, and char. Hydrogeneration should also be included. Under bioconversion, include enzymatic hydrolysis, anaerobic digestion, and landfills and

composting of garbage and sewage sludges to produce gas, dry fuel, alcohols and fertilizer.

Under material recovery, include collection, processing and utilization of glass, paper, waste oil, rubber, metals and plastics.

Excluded from this program are:

1) wood residues (Task 4),

2) animal manure and agricultural waste (Task 4),

3) thermal wastes,

4) sewage sludge as fertilizer (Program 1.3),

A number of technologies exist at various stages of development. The work required under the program is to modify these technologies to suit Canadian conditions and to demonstrate their technical, logistical and economic viability.

E. Program Implementation

The program can be broken down into the following sub-programs:

Sub-Program		Objective
1.5.1	Combustion	To modify processes for direct incineration of combustible municipal wastes for the production of heat for space heating, municipal operations and electricity generation for Canadian conditions.
1.5.2	Pyrolysis	To develop processes for the production of fuels from combustible muncipal wastes through pyrolysis and hydrogeneration.

1.5.3	Bioconversion	To develop enzymatic hydrolysis, anaerobic digestion, and composting processes to produce dry fuel, fertilizer, methane and alcohols from sewage sludge and organic material in garbage.
1.5.4	Material recovery	To develop systems for material recovery and reuse from municipal and industrial waste.

Reasonably well-developed technology already exists in the combustion sub-program, but modifications are necessary to suit Canadian conditions. These modifications should be incorporated into demonstration programs on a cost-shared basis with the provinces. Technologies for pyrolysis are at a similar state of development.

Bioconversion processes still require substantial R&D. At this time, it is not clear how technological developments will be implemented.

Material recovery systems have been developed for use within the federal government and these will be transferred to provincial and municipal governments and the private sector.

Sub-Program	Time Period		
	1979 - 1985	1985 -2000	Beyond 2000
1.5.1 Combustion	_____		
1.5.2 Pyrolysis	_____		
1.5.3 Bioconversion			
. organic garbage	_____		
. sewage sludge	_____	_____	
1.5.4 Material recovery	_____		

F. International Cooperation

There is much foreign activity in this area. The IEA has no activity in this area at present, and there is little scope for formal bilateral activity.

PROGRAM 1.6 - COMBUSTION OF OIL AND GAS

A. Rationale

With the exception of hydro power the bulk of our power and heat needs are supplied by the combustion of conventional fuels. Most of our oil and gas, with the exception of non-energy uses and internal combustion engines, is burned in domestic and industrial equipment to supply heat, hot water, process heat, steam and electricity.

In domestic heating systems, an estimated 20 percent reduction in fuel consumption is achievable through a number of measures applicable to present systems. In the commercial sector, heating systems may be more efficient than those in the domestic sector, but it is believed that there is room for signifigant improvement. Similarly, a mumber of possible actions can be taken in current industrial combustion systems to reduce fuel consumption. These represent short term options for the program. For the longer term a number of promising technologies which could result in substantial savings should be researched.

The Canadian Combustion Research labratories (CCRL), of CANMET (EMR), is the acknowledged leader in combustion research in Canada. CCRL provides advice, information and expertise to industry and to heating equipment manufacturers.

B. Program Organization and Management

The program is managed by CANMET which is also responsible for coal combustion, coal gasification and liquifaction, and cogeneration and energy cascading. CANMET has been involved in these areas for a considerable period and has established many links with the private sector and universities. It has traditionally provided advice and information to the combustion equipment industry. CANMET, like NRC, performs R&D by developing a cadre of in-house expertise performing much of the research and contracting out where outside expertise exists.

In the domestic area CANMET performs all the research on oil systems in-house. Work on gas systems is done in cooperation with CGRI. Any innovative hardware must be

patented, certified by CSA and licenced to manufactures. In the industrial area, CANMET cooperates with industry to improve existing equipment and to develop new combustion equipment.

C. Program Objectives

The objectives of Program 1.6 are as follows:

1) to improve the fuel efficiency of present combustion systems, both domestic and industrial,
2) to modify present systems to use broader-cuts and non-conventional petroleum fuels, both domestic and industrial,
3) to increase the efficiency ot overall heating systems both domestic and industrial
4) to develop efficiency standards for combustion systems and overall heating systems,
5) to develop new combustion systems and overall heating systems
6) to examine novel technologies for heat production.

Although a number of these novel technologies are not combustion processes, they should be included in this program because they are related to this program and the requisite expertise is in CANMET.

D. Program Definition

From the perspective of defining the program, two major areas can be examined: industrial combustion processes, and domestic and small scale applications. In the industrial area, the program should address the following:

1) multifuel industrial burners,
2) industrial high-temperature gas turbines,
3) multifuel industrial turbines,
4) industrial furnace design,
5) burner development -- modulating as opposed to cycling,
6) improved boiler efficiency by factors such as combustion chamber pre-purge stack draft control and pre-heated combustion air, and oxygen enrichment of combustion air,
7) novel heating technologies such as infrared, microwave and catalytic.

In the domestic and small scale applications area, the program should address the following:

1) existing furnace retrofit packages,
2) matched burner/furnace combinations,
3) furnace performance standards,

4) new burner development, eg. pulse jet burner,

There are a number of areas related to oil and gas combustion that are not covered under this program. These are as follows:

1) internal combustion engines (Program 1.2)
2) reciprocating engines,
3) coal in oil combustion (Task 2),
4) basic combustion science,
5) large gas turbines for central power generation.

In the domestic sector, demonstration projects in this program will be inexpensive and should be retained in the program. In the industrial area, demonstration projects will involve two aspects. The first involves modification of existing systems; the second involves development of new hardware. The former aspect should not be expensive and should be done in cooperation with industry on the premises. Hardware demonstrations, since they are more expensive, should be carried out in a different fashion. This will be explained in Part 3 of this paper.

E. Program Implementation

The program can be broken down into the following sub-programs:

	SUB-PROGRAM	OBJECTIVE
1.6.1	New industrial furnaces	To design more efficient industrial furnaces by using better insulation, and refractories.
1.6.2	Industrial burners	To develop multi-fuel industrial burners and to examine the use of modulating and cycling burners.
1.6.3	Boiler efficiency	To improve boiler efficiency by developing methods such as combustion chamber pre-purge, stack draft

	SUB-PROGRAM	OBJECTIVE
		control, pre-heated combustion air and oxygen enriched combustion air.
1.6.4	High-temperature gas turbines	To develop appropriate sized high-temperature gas turbines for peak load electricity generation, pipeline pumping, marine installations and railway motive power.
1.6.5	Multi-fuel industrial turbines	To develop multi-fuel combustion systems for industrial gas turbines.
1.6.6	Novel heating systems	To research novel heating systems such as infrared, microwave and catalytic.
1.6.7	Domestic gas heating systems	To develop retrofit packages to increase energy efficiency, to develop matched burner/furnace combinations, and to develop performance standards.
1.6.8	Domestic oil heating systems	To develop retrofit packages to increase energy efficiency, to develop matched burner/furnace combinations, and to develop performance standards.

Work in boiler efficiency, domestic gas and oil heating and some aspects of industrial burners will mainly involve modifications of present equipment by minor design changes or add-on devices. These sub-programs will have an impact in the short term, and the work should be carried out in cooperation with the equipment manufactures and industrial users.

Industry performs work on new industrial furnaces, industrial burners and turbines. The federal government's role in this case is to be aware of these programs filling in gaps where necessary.

Novel heating systems will have an impact in the long term, and work should be done in CANMET and through unsolicited proposals.

SUB-PROGRAM		TIME PERIOD		
		1979 -1985	1985 -2000	Beyond 2000
1.6.1	New industrial furnaces	———		
1.6.2	Industrial burners	———		
1.6.3	Boiler efficiency	———		
1.6.4	High-temperature gas turbine.	———		
1.6.5	Multi-fuel industrial turbines	———		
1.6.6	Novel heating systems	———	———	———
1.6.7	Domestic gas heating systems	———		
1.6.8	Domestic oil heating systems	———		

F. International Cooperation

Combustion science is subject of widespread international interest which is expressed through the Combustion Institute of which there is a Canadian section. The IEA has an implementing agreement on combustion which Canada has not joined. The possible value of Canadian participation in this program should be examined.

PROGRAM 1.7 - INDUSTRIAL PROCESSES

A. Rationale

Industrial energy usage, including energy supply industries and non-energy uses, currently accounts for almost 40% of Canadian end-use of energy, making industry the major energy use sector in Canada.

Energy conservation in this sector is very important since the opportunities for more efficient energy utilization, on the basis of normal commercial criteria, are numerous and potentially offer substantial energy savings. Unless Canadian industry can utilize energy more efficiently, increasing prices of energy resources will adversely affect Canada's competitive position.

Estimates suggest that by 1990, with "housekeeping measures" such as maintenance and insulation, modifications to existing technology and investment in new equipment, energy efficiency can be improved by about 20 to 25% from the level that would have prevailed if pre-1973 trends had continued. Applied R&D demonstration and diffusion of technologies in waste utilization, operations modification, design modification and cogeneration could by 1990 increase these savings to nearly 35%. Development, demonstration and diffusion of new processes and substitution of energy sources could produce further significant savings.

B. Program Organization and Management

Program 1.7, as presently constituted, consists only of the Industrial Energy R&D Program (IERD). The IERD Program is a cost-shared program designed to encourage and assist Canadian industry to undertake R&D of improved processes and equipment that will reduce energy consumption in industry. The nature of this program tends to limit its scope to demonstration projects which are generally a modification of existing processes by using available technology.

The IERD program is managed by the Enterprise Development Branch of Industry, Trade and Commerce (ITC). This Branch also manages the Enterprise Development Program (EDP), which provides assistance for the development of projects past the R&D stage. The EDP program provides assistance for commercialization of a product.

Proposals for the IERD program are also screened by the EDP program. In practice, the constraints on the IERD program limit it to least-risk ventures. This tends to exclude entrepreneurs, inventors and small technologically-based companies. Yet, these are the sources of most industrial innovation. A new sub-program is therefore necessary to handle this kind of innovation, which will have a longer-term impact. NRC would be the logical agency to manage this sub-program.

C. PROGRAM OBJECTIVES

The objectives of this program should be as follows:

1) to encourage and assist Canadian industry to undertake R&D of improved processes and equipment which will reduce energy consumption in industry;
2) to develop new industrial processes.

D. PROGRAM DEFINITION

Under the IERD program, projects can be classified as follows:

1) design modification
   - redesign unit operations where possible to increase waste heat recovery
2) process integration
   - coproduce steam and electrial or mechanical power
3) waste utilization
   - utilize waste gas streams and solid and liquid wastes as fuel and recycle waste materials
4) operation modification
   - modify operation of processes to optimize energy efficiency, down time, outputs and equipment integrity.

A new sub-program should be set up to research new industrial processes and to introduce recently developed processes which will replace existing processes.

The IERD program will generally not develop any new handware; rather it will incorproate existing hardware in present plants which will in fact result in new plant designs.

There are a number of related areas mostly involving discrete hardware design and development. The major exclusions are as follows:

1) heat pump systems (Program 1.8),
2) industrial furnaces (Program 1.6),
3) industrial turbines (Program 1.6),
4) cogeneration plant (Program 1.4),
5) heat exchange equipment (Program 1.4),
6) heat storage (Program 1.8),
7) use of renewable resources (Task 4).

The IERD program is a cost-shared program with industry and proposals originate from industry. The projects will generally be of the nature of demonstrations.

The initial Canadian application of a technology which has been proven abroad should not be funded under the IERD program.

E. PROGRAM IMPLEMENTATION

The program can be broken down into the following sub-programs:

	SUB-PROGRAM	OBJECTIVE
1.7.1	IERD program	To encourage and assist Canadian industry to undertake R&D to improve energy efficiency of current equipment and processes.
1.7.2	New industrial processes	To develop new industrial processes and to introduce recently developed processes.

The IERD program is expected to have an impact in the short term. The introduction of newly developed processes will have an impact in the medium term. New industrial processes, which are generally at an early stage of development, will have an impact in the long term.

SUB-PROGRAM	TIME PERIOD		
	1979 -1985	1985 -2000	Beyond 2000
IERD program	———		
New industrial processes			
. introduce recently developed processes	———————		
. develop new industrial processes	———————	———————	———————

F. INTERNATIONAL COOPERATION

The IEA has set up expert groups in energy conservation R&D in the pulp and paper, iron and steel and cement industries to examine the possibilities for international cooperation. No agreement has as yet been signed. FERA participated in the iron and steel discussions and PPRIC in the pulp and paper discussions. There was no Canadian industrial participation in the cement discussions.

Initiatives for involvement in energy conservation R&D in industry at an international level must come from industry rather than from government. The federal government should attempt to avoid funding industrial participation in an implementing agreement, but it should provide advice to any industrial signatories.

NATO-CCMS has also been involved in the development of industrial data bases in a number of industries. As these are completed, they are passed onto the IEA with suggestions for R&D programs.

PROGRAM 1.8 - ENERGY CONVERSION AND STORAGE AND HYDROGEN

A. Rationale

Energy conservation and substitution require the development of advanced technologies in conversion, storage and energy carriers. A large number of technologies have been suggested as solutions to problems in these fields. During the five years since the oil embargo, the technical and popular literature have been deluged with contributions from proponents of various schemes, many of which are highly speculative.

Canada does not possess the technical or economic resources to research all these possibilities. Coverage of the whole field with probable resources will achieve little more than an awareness level of activity, which would not be productive. Therefore, choices had to be made and pursued to their logical conclusions. A level of awareness should also be maintained in other areas which have been assigned a high priority by other countries.

The program thrust is directed primarily towards sectors which consume most of our petroleum fuels. It addresses new problems in energy conversion which derive from the exploitation of new resources. The efficient utilization of existing resources by the application of advanced conversion technologies is also included.

The second component of the program is the storage of energy to allow the introduction of new energy carriers into already established consumption systems and to maximize the utilization of intermittent renewable energy sources.

The third component of the program is hydrogen systems, including its production, transmission, storage and utilization.

Work related to these areas is funded in Canadian universities and the federal government maintains expertise in NRC, CANMET and DREO. Although there are some research programs in Canadian industry, these represent areas of considerable risk. Therefore, federal government involvement is necessary to accelerate development.

B. Program Organization And Management

This program comprises a number of diverse activities which are individually managed in NRC, CANMET, and the Defense Research Establishment - Ottawa (DREO). Many areas of this program have traditionally been of interest to universities, which have a number of ongoing projects. Many of these projects are at the basic level of research. Overall coordination is provided by the Department of Chemistry of NRC.

This program began as an amalgamation of a number of existing activities which were not necessarily focused from an energy viewpoint. An NRC Associate Committee on Energy Conversion, Storage and Hydrogen Systems has been established and one of its functions is to determine which programs should be pursued.

This program is not directed to energy conservation R&D as such, but will develop advanced technologies aimed at substitution and greater systems efficiency resulting in energy conservation. A number of these technologies also transcend the energy conservation task and are crucial to solar and wind energy and coal. Therefore, a large number of participants are involved in the decision-making process.

C. Program Objectives

The objectives of Program 1.8 are as follows:

1. To develop energy storage technologies which can take advantage of a range of energy inputs and which are suitable for applications in central power generation systems, domestic and industrial heating systems and the transportation system.

2. To develop energy conversion technologies which will result in more efficient utilization of energy resources and which are suitable for applications in central power generation systems, domestic and industrial heating systems and the transportation system.

3. To develop heat pumps suitable for application in domestic and industrial heating systems.

4. To develop technologies for the production, transportation, storage and utilization of hydrogen in the long term.

5) To maintain an adequate level of awareness of foreign activities in areas in which Canada has no domestic programs.

D. Program Definition

From the perspective of defining the program, the work can be classified under six areas:

1) electrochemical devices, comprising advanced batteries and fuel cells,

2) hydrogen systems, comprising production, transmission, storage and utilization,

3) flywheels, comprising composite rotors, component and systems development,

4) heat pumps, comprising gas and electric,

5) heat storage, comprising sensible, latent and chemical storage.

6) awareness of other technologies in the program area.

A number of storage and conversion technologies are excluded from this program. These exclusions are as follows:

1) advanced power cycles (CEA?)

2) fluidized bed combustors (Task 2),

3) waste pyrolysis systems (Program 1.5),

4) photo-and bio-conversion processes (Task 4),

5) ocean thermal energy conversion, tidal and wind conversion systems (Task 4),

6) combustion technology (Program 1.6; Task 2),

7) improved electric motors (CEA?),

8) nuclear batteries (Task 3),

9) geological storage of petroleum and natural gas (Task 2),

10) reverse dialysis (Task 4),

11) compressed air and pumped water storage (CEA),

12) small-scale sensible heat storage (Task 4),

13) hydrogen for heavy oil and bitumen upgrading (ACERF and AOSTRE),

14) hydrogen for metalurgical reduction (Program 1.7),

15) hydrogen as a transportation fuel.

Highly speculative technologies are omitted from the above.

E. Program Implementation

The program can be broken down into the following sub-programs:

	SUB-PROGRAM	OBJECTIVE
1.8.1	Electrochemical devices	To undertake directed electrochemical studies aimed at the basic problems of advanced batteries and fuel cells.
1.8.2	Hydrogen systems	To lay the foundation for the deployment of hydrogen in the long term by investigating and developing appropriate technologies for its production, transportation, storage and utilization.
1.8.3	Flywheels	To develop composite rotors and other components for flywheel systems.

1.8.4	Heat pumps	To investigate the applications of heat pumps and to develop heat pump systems suitable for domestic and industrial applications (gas-fired and electric-powered, and compression and absorption).
1.8.5	Heat storage	To develop processes for the storage and transmission of thermal energy as sensible heat, latent heat and in the chemical bond.
1.8.6	Awareness	To maintain an intramural awareness of developments in MHD, in thermoelectric and thermionic systems, and generally in speculative technologies.

The hydrogen systems work is being done through a small in-house program in DREO, a cost-shared program with Noranda Electrolyser, and participation in the IEA implementing agreements on hydrogen. These arrangements are being examined further by the NRC Associate Committee on Energy Conversion, Storage and Hydrogen Systems.

The flywheel program is primarily an in-house NRC activity. The awareness program should be an in-house activity. Heat pumps should be an area of cooperation between industry and the federal government. Heat pumps are also of interest to the provinces: Quebec intends to develop a heat pump industry. CGRI is interested in gas heat pumps and intends to collaborate with the American Gas Institute which has plans to develop a range of gas heat pumps.

Heat storage as sensible heat, latent heat and chemical energy poses a variety of problems requiring research by universities, industry and the federal government.

There is considerable international activity in advanced batteries and fuel cells. The Canadian effort should focus on directed studies aimed at the basic problems associated with these technologies.

SUB-PROGRAM	TIME PERIOD		
	1979 -1985	1985 -2000	Beyond 2000
Electrochemical devices			
- advanced batteries	———		
- fuel cells	———		
Hydrogen systems			
- production	———		
- transportation	———		
- storage	———		
- utilization	———	———	———
Flywheels	———		
Heat pumps			
- electric	———		
- gas	———		
Heat storage			
- sensible	———		
- latent	———		
- chemical	———		
Awareness	Continuing		

F. International Cooperation

There are two existing IEA implementing agreements on heat pumps: one on existing heat pump technology and the other on advanced heat pumps. Canada has not signed either agreement. Both these agreements deal with information exchange at the present time. Canada should consider joining later annexes after we have developed a domestic program.

Canada has signed an IEA implementing agreement on the production of hydrogen from water. This agreement has also been signed by two Canadian companies: Noranda Mines and Electrolyser. The Canadian participation is a combination of an industrial and an intramural effort. International cooperation is probably the best way to handle most components of the hydrogen program at the present time.

No IEA programs exist in the other areas of Program 1.8 and there is not much scope for bilateral cooperation on a government-to-government basis.

PROGRAM 1.9 - COMMUNITY SYSTEMS

A. Rationale

Historically, community planning practices have paid little or no attention to the energy consequences of factors such as population size and density, city shape and area, infrastructure patterns, climate and location, and land use configurations. Cities are characterized by sprawl over large areas, suburbia and low population densities, haphazard development, segregation of land use activities and physical layouts which are insensitive to climate and human activites. These urban characteristics are the result of piecemeal planning which did not adequately consider energy consumption.

Innovative design for new urban areas and urban redevelopment could result in substantial energy savings. In addition, community system redesign is necesary to implement new energy technologies such as solar energy, total energy systems, district heating, and utilization of garbage. New community design, of course, must consider environment and satisfaction of human needs as the major parameters.

B. Program Organization And Management

This program will be managed by the Ministry of State for Urban Affairs (MSUA) until March 31, 1979. After this date, responsibility for this program should be transferred to CREB because it is a trans-sectoral program which incorporates aspects of other programs of Tasks 1 and 4.

Results from this program are expected over the medium and longer term. Projects should be done in cooperation with the provinces and municipalities.

C. Program Objectives

The objectives of Program 1.9 are as follows:

1) to analyze the patterns of community energy consumption which are related to urban form and to develop systems and techniques for reducing energy consumption in present urban areas,

2) to develop innovative design for urban renewal which offer energy consumption and which also satisfy human needs,

3) to develop designs for communities to implement new technologies such as district heating, total energy systems, utilization of garbage as fuel, efficient transportation systems, and solar energy,

4) to build model communities which demonstrate efficient new community designs.

D. Program Definition

Program 1.9 should address the following as project areas:

1) integrated analysis of community energy consumption patterns,

2) integrated design for urban renewal incorporating a reduced need for transportation and smaller communities,

3) conceptual designs for Canadian integrated community energy systems including centralized systems to supply all the energy consuming services required by a community such as heating, cooling, electricity, solid waste processing, sewage treatment, utilization and disposal, communications, solar heating and geological heat storage,

4) demonstration communities with combinations of the above concepts. Demonstration projects should be done in cooperation with HUDAC, municipalities, the provinces and of course community interest groups.

This program should be considered as an integrative systems program integrating the technologies developed in the other programs of Task 1 and certain programs of Task 4.

F. Program Implementation

The program can be broken down into the following sub-programs.

1.9.1	Energy Consumption patterns	To analyze community energy consumption patterns.
1.9.2	Low energy urban renewal	To develop urban renewal designs incorporating existing energy conservation technology.

1.9.3	New Community systems	To develop conceptual designs for new community systems incorporating new conservation and renewable technologies and integrated energy systems and services.
1.9.4	Model Communities	To demonstrate conceptual designs for new community systems.

SUB-PROGRAM	TIME PERIOD		
	1979 -1985	1985 -2000	Beyond 2000
Energy consumption patterns	____		
Low energy urban renewal	_____		
New community systems	_____	_____	
Model communities	_____	_____	

F. International Cooperation

There was an IEA implementing agreement on ekistics with the United States and Greece as the only participants.

There is a new IEA agreement, entitled "Buildings and Community Systems," which now incorporates ekistics. It is expected that possible annexes related to Program 1.9 could be of interest to Canada.

The UN Economic Commission on Europe (ECE) is another international forum for exchange of ideas on community systems design concepts. Canada hosted in 1977 a seminar entitled "The Impact of Energy Considerations on the Planning and Development of Human Settlements", which resulted in an exchange of concepts from a variety of countries.

PROGRAM 1.10 - CONSUMER PRODUCTS AND LIFESTYLES

A. Rationale

Consumer products and lifestyles represent an important area for energy conservation. The increased efficiency of energy utilization of present consumer products will probably save only a small quantity of energy, but improved design for repairability, durability, recycling and a reduction in both packaging and disposable items could result in substantial energy savings. However, consumer behaviour in purchase, use and disposal of products is not yet well understood.

Shifts to less energy intensive lifestyles through new consumer practices, changed living patterns, reduction of artificial stimulation of demand through marketing and advertising and changes in patterns of recreation and tourism will undoubtedly result in large reductions in energy demand.

Such changes on a large scale could have far reaching social and economic implications, which should be thoroughly investigated.

B. Program Organization And Management

The program is managed by the Bureau of Consumer Affairs of CCA, whose mission is to assure the rights of Canadian consumers within the market system.

C. Program Objectives

The objectives of Program 1.10 are as follows:

1) To identify the potential for changes in consumer products in terms of improved designs for energy efficiency, durability, repairability and recycling, including analysis of the economic and social implications, and to develop standards aimed at achieving this potential,

2) To identify the potential for the reduction of packaging and disposable items and to develop standards for achieving this potential,

3) To identify the factors influencing consumer decisions and to identify the potential for lifestyle changes, and to develop the necessary information and education mechanisms for consumer choice decisions.

D. Program Definition

The program should address the following project areas:

1) design of more energy efficient appliances,
2) re-manufacturing and recycling of appliances,
3) appliance durability and repairability,
4) economic consequences of longer product life,
5) life cycle costing,
6) the nature of the second-hand and used product market,
7) factors influencing consumer purchasing behaviour,
8) reduction of packaging and disposable items,
9) standardized packaging,
10) lifestyle changes,
11) "conserver society" implications.

The following areas should be excluded:

1) automobiles (Program 1.2),
2) furnaces (Program 1.6),
3) heat pumps (Program 1.8),
4) solar collectors (Task 4),
5) windmills (Task 4),
6) community systems design (Program 1.9),
7) buildings (Task 1.1).

E. Program Implementation

The program can be broken down into three sub-programs:

Sub-Program		Objective
1.10.1	Appliances	To develop more energy efficient appliances and systems for longer life cycles.
1.10.2	Packaging and disposable items	To reduce the level of packaging and disposable items.
1.10.3	Lifestyles	To identify the potential for lifestyle changes consistent with energy conservation.

CCA can implement research results by persuading consumers and manufacturers to take voluntary action or by setting guidelines and standards to be followed. Design changes must of course be given approval from CSA or CGA.

Developments in the area of appliances and packaging can be expected to have an impact in the short term. Standardization of packaging will require extensive energy analysis, and its impact can be expected in the medium term.

Lifestyle changes require considerable examination because the complex relationships are not well understood. There is a close link between lifestyles and the areas of energy conservation that are under study in the other programs of Task 1, and the research of Task 4.

Sub-Program	Time Period 1979 -1985	1984 -2000	Beyond 2000
1.10.1 Appliances			
. energy efficient design	———		
. durability and repairability	———	———	
. consumer purchasing behaviour	———		
. life cycle costing	———		
1.10.2 Packaging and disposable items			
. reduction of packaging	———		
. reduction of disposable items	———		
. standardization of . packaging	———		
1.10.3 Lifestyles	———	———	———

F. International Cooperation

There is no IEA activity in this are at present and there is little scope for formal bilateral cooperation. There is however, some foreign activity and Canada maintains informal links with these countries.